Rising Watershed and Bay Water Temperatures—Ecological Implications and Management Responses

June 2021 Healthy Watersheds Update

Nora Jackson, CRC

Workshop objectives

* Summarize major findings on the ecological impacts of rising water temperatures, including science-based linkages between causes and effects; and
* Develop recommendations on how to mitigate these impacts through existing management instruments, ranging from developing indicators, identifying best management practices, and adapting policies.

Phase 1 (2021): Information collection and synthesis

- In-depth compilations of our current understanding about watershed and tidal water temperature increases

Phases 2 and 3 (early 2022):Two-part STAC Workshop recommending CBP responses

- Workshop Day 1: Concurrent tracks for watershed and tidal areas, addressing ecological impacts and management implications
- Workshop Day 2: Discussion on resulting synthesis from Workshop 1, refine findings and develop action recommendations

1. Stream Health

… Watershed Fish Populations and Overall Stream Health Including Identification of Critical Temperatures/Temperature Changes (*Steve Falkner, USGS and Frank Borsuk, EPA*)

2. Fisheries

… Bay Fish, Shellfish and Crab Populations and Their Prey Including Identification of Critical Temperatures/ Temperature Changes (*Bruce Vogt, NOAA and Justin Shapiro, CRC)*

3. SAV

…Submerged Aquatic Vegetation Communities and Individual Species Including Identification of Critical Temperature Changes *(Brooke Landry, MD DNR)*

4. Watershed Characteristics

Identification of the Characteristics of Watersheds and Certain Key Landscape Factors to Inform Opportunities for Conservation and Reducing Land Conversion in Areas Vulnerable or Resilient to Stream Temperature Changes (*Renee Thompson, USGS and Nora Jackson, CRC)*

5. Ecosystem processes

Past, Current and Projected Changes in Watershed and Tidal Water Temperatures and Implications for Ecosystem Processes Influencing Stream, River and Estuarine Health *(Rich Batiuk and Nora Jackson, CRC)*

6. Factors and geographies

Factors and Geographies Most Influencing Water Temperatures in Local Waters Throughout the Watershed and Across all the Bay's Tidal Waters *(Rich Batiuk, Gary Shenk, USGS and Lew Linker, EPA)*

7-8. BMPs; Habitat restoration

Where Habitat Restoration Can Mitigate Rising Water Temperatures and Where Rising Temperatures Can Impair Habitat Restoration and Identification and Characteristics of BMPs Which Can Help Mitigate or Exacerbate Rising Local Stream, River, Groundwater and Tidal Water Temperatures (*Katie Brownson, USFS and Tom Scheuler, CSN)*

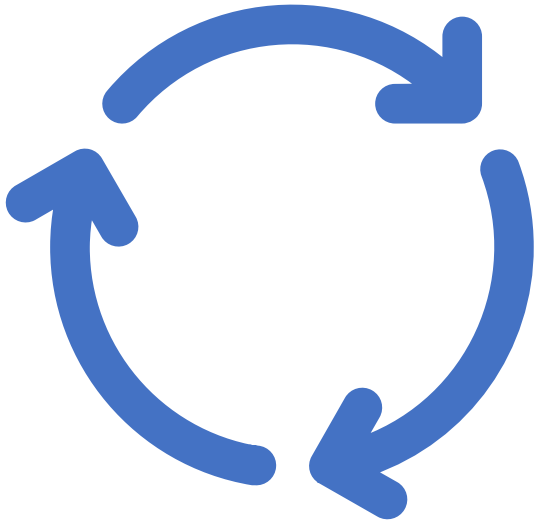
9. Temperature indicator

Synthesis of Information Supporting Development of and Options for a Tidal Bay Temperature Indicator *(Julie Reichert-Nguyen, NOAA)*

10. Monitoring networks

Needs for Enhancing the Partnership's Monitoring Networks as Needed to Support Reporting of the Water Temperature Indicator or Other Instruments *(Scott Phillips, USGS)*

Monday, June 21, 9:30-4pm



Special cross-workgroup meeting to share results from synthesis assignments in preparation for the Rising Water Temperature STAC Workshop.

Overall goal of meeting is to **share and assess what we know** and don't know about the effects of rising water temperatures on habitats and living resources and **potential management strategies to reduce vulnerability and increase resilience.**

From our discussions, we will see if there are emerging storylines about the effects of rising water temperatures on non-tidal and tidal resources and identify strong and weak points in information.

The **morning sessions** focus on **non-tidal watershed** topics and afternoon on **tidal Bay** topics.

Watershed Classification

Healthy ⟷ **Unhealthy**

Risk Factors
(informed by CHWA and CBP Land Data team)

- Population Density
- Impervious Cover (%)
- Tree Cover (%)
- Hydric Soils (%)
- Road x stream crossing density
- Probability of land conversion

Diagnostic Measures
(informed by USGS Science and geospatial contract work)

- Stream flow
- Stream temperature
- Stream incision/floodplain connectivity
- Aquatic community composition
- Toxics
- Nutrients
- Sediment

Landscape Condition

Subindex score:

Metric values

- % Natural Land Cover (Ws)*
- **% Forest in Riparian Zone (Ws)**
- Population Density (Ws)
- **Housing Unit Density (Ws)**
- Mining Density (Ws)
- **% Managed Turf Grass in Hydrologically Connected Zone (Ws)***
- **Historic Forest Loss (Ws)**

Hydrology

Subindex score:

Metric values

- % Agriculture on Hydric Soil (Ws)
- **% Forest (Ws)***
- % Forest Remaining (Ws)
- % Wetlands Remaining (Ws)
- % Imperviousness Cover (Ws)*
- Road Stream Crossing Density (Ws)
- **% Wetlands (Ws)***

Habitat

Subindex Score:

Metric values

- National Fish Habitat Partnership (NFHP) Habitat Condition Index (Catchment)
- **% Natural Connectivity (Catchment)**
  - **Habitat Condition Index – Local**
  - **Habitat Condition Index – Network**
  - **Habitat Condition Index – Cumulative**

Geomorphology

Subindex Score:

Metric values

- Dam Density (Ws)
- % Vulnerable Geology (Ws)
- Road Density in Riparian Zone (Ws)
- % Impervious in Riparian Zone (Ws)*

Water Quality

Subindex score:

Metric values

- **% of Stream Length Impaired (Catchment)**
- **Estimated Nitrogen Load from SPARROW Model (lbs/acre/yr) (Ws)**
- **Nitrogen, Phosphorus, and Sediment Load from Chesapeake Bay Model, by Sector (Ws)**

Biological Condition

Subindex score:

Metric values

- **Outlet Aquatic Condition Score (Catchment)**

Watershed Vulnerability Metrics

Land Use Change

Metric values

- **% Increase in Development (Catchment)**
- **Recent Forest Loss (Ws)**
- **% Protected Lands (Ws)**

Wildfire

Metric value

- **% Wildland Urban Interface (Ws)**

Water Use

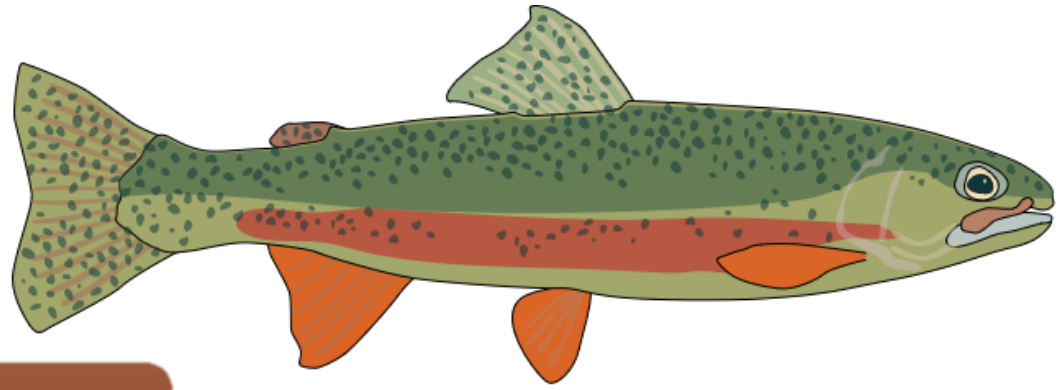
Metric values

- Agricultural Water Use (Catchment)
- Domestic Water Use (Catchment)
- Industrial Water Use (Catchment)

Climate Change

Metric values

- **Change in Probability of Brook Trout Occurrence with 6 C Temperature change (Catchment)**
- **NALCC Climate Stress Indicator (Catchment)**

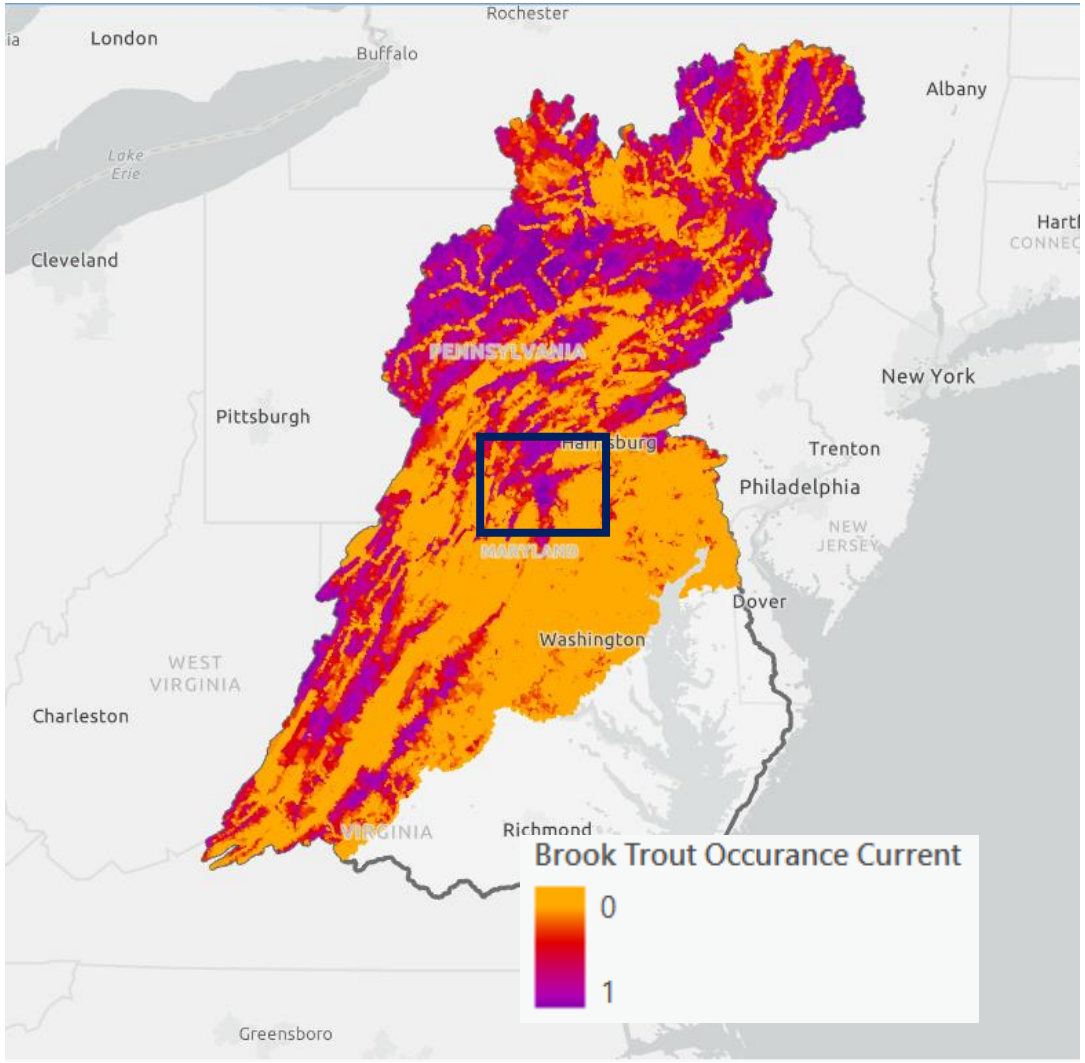


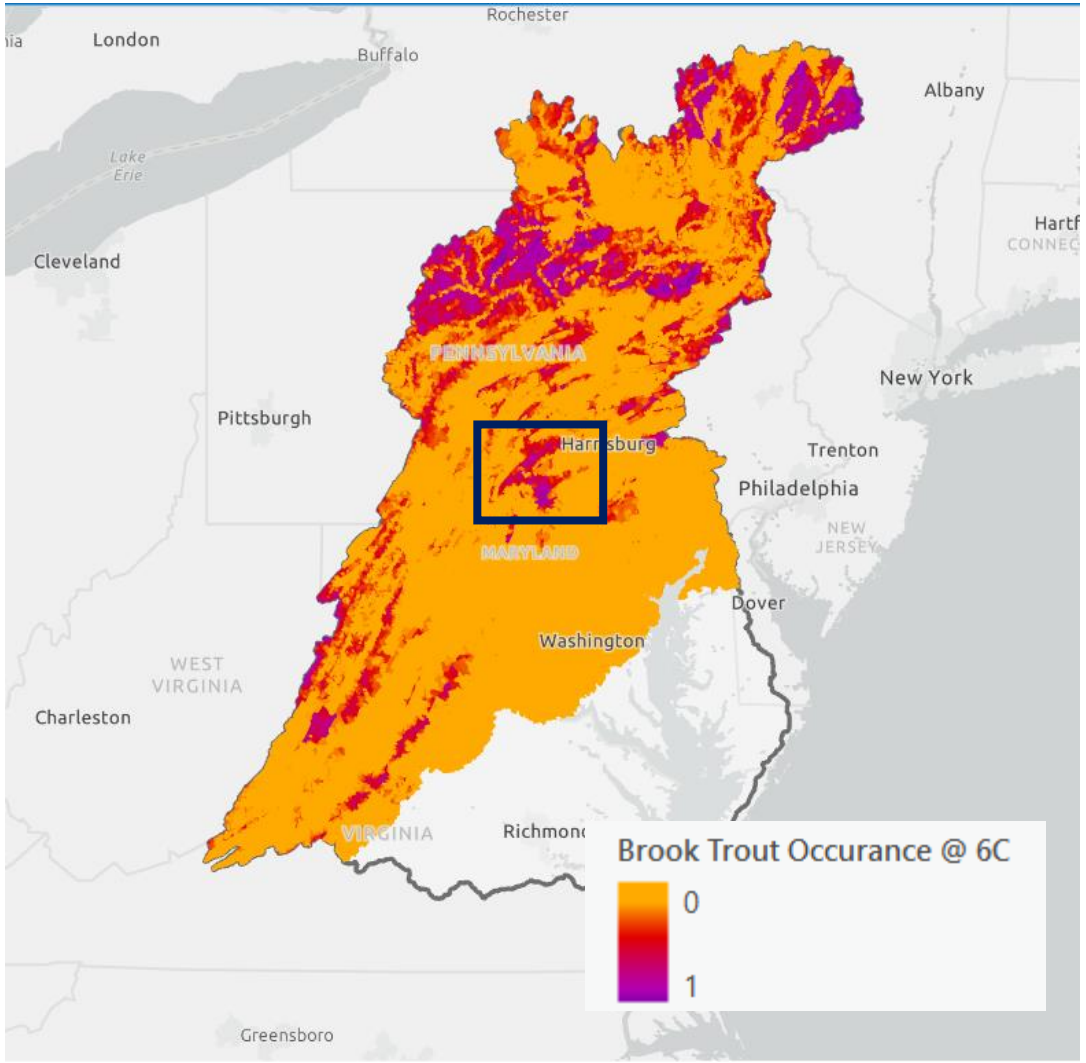
Change in Stream Temperature

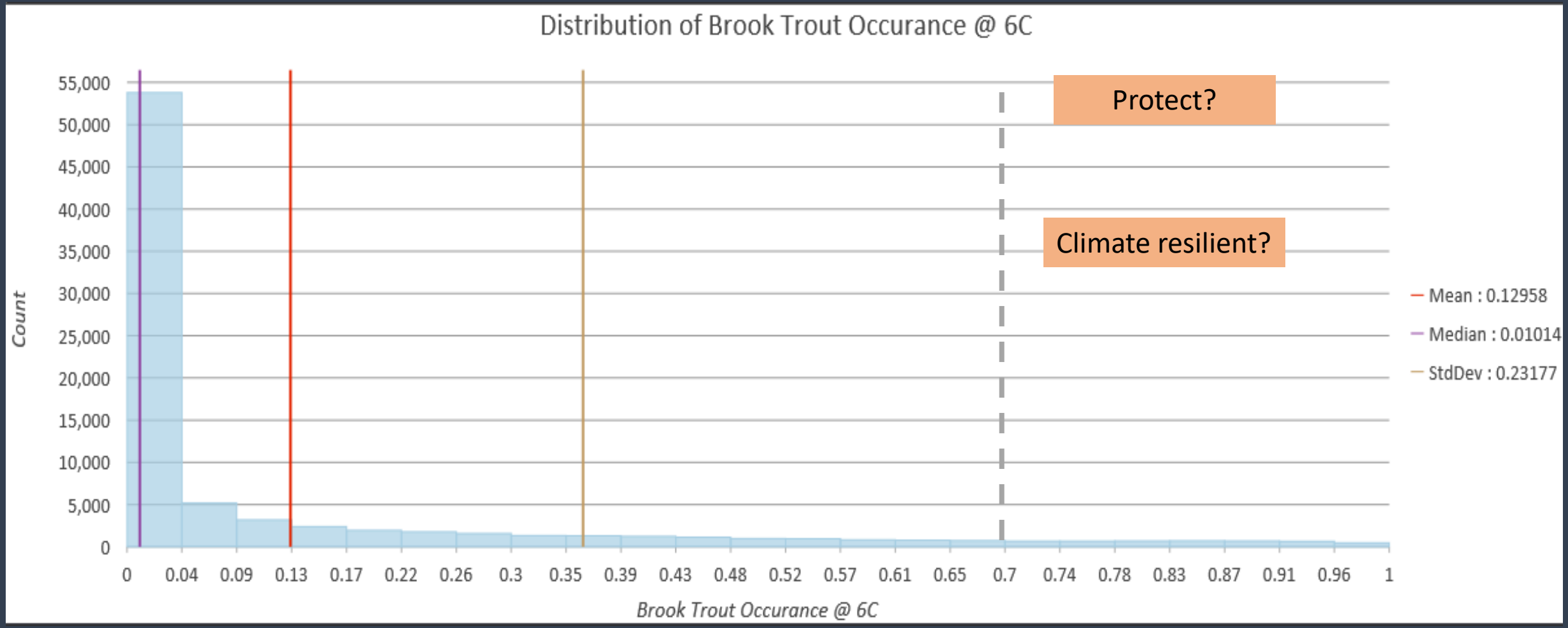
Change in Brook Trout Habitat

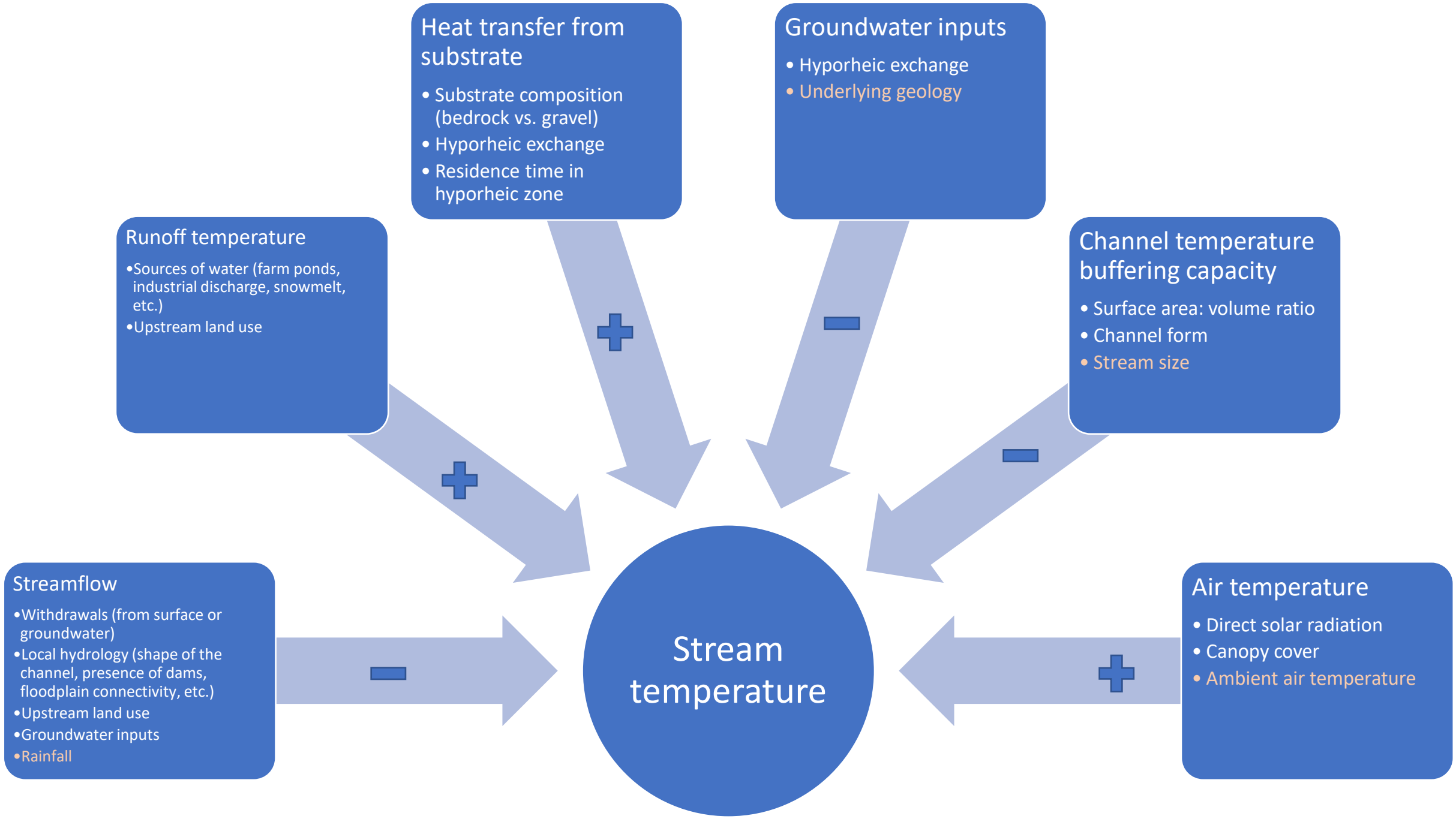
Where to protect/restore brook trout habitat to increase climate *resilient* occupied habitat?

Current Brook trout vs.
Brook trout 6 deg C. increase



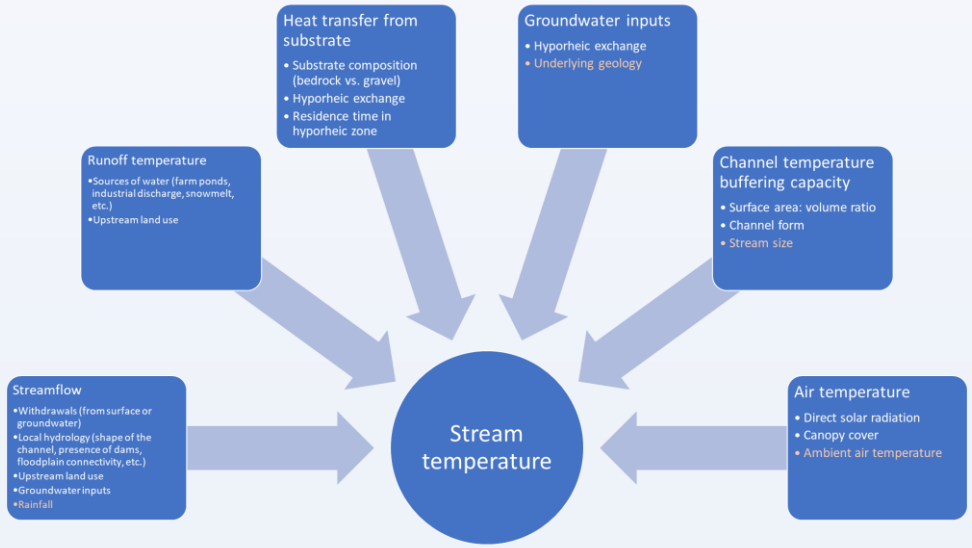



Distribution of Brook Trout Occurance @ 6C
Protect?
Climate resilient?
Mean : 0.12958
Median : 0.01014
StdDev : 0.23177
Count
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
0.04
0.09
0.13
0.17
0.22
0.26
0.3
0.35
0.39
0.43
0.48
0.52
0.57
0.61
0.65
0.7
0.74
0.78
0.83
0.87
0.91
0.96
1
Brook Trout Occurance @ 6C

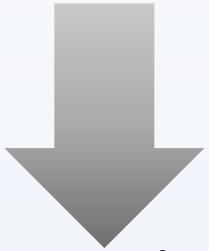

Heat transfer from substrate
• Substrate composition (bedrock vs. gravel)
• Hyporheic exchange
• Residence time in hyporheic zone
Groundwater inputs
• Hyporheic exchange
• Underlying geology
Runoff temperature
•Sources of water (farm ponds, industrial discharge, snowmelt, etc.)
•Upstream land use
Channel temperature buffering capacity
• Surface area: volume ratio
• Channel form
• Stream size
Streamflow
•Withdrawals (from surface or groundwater)
•Local hydrology (shape of the channel, presence of dams, floodplain connectivity, etc.)
•Upstream land use
•Groundwater inputs
•Rainfall
Stream temperature
Air temperature
• Direct solar radiation
• Canopy cover
• Ambient air temperature

What landscape factors make a watershed more vulnerable or resilient to stream temperature changes?

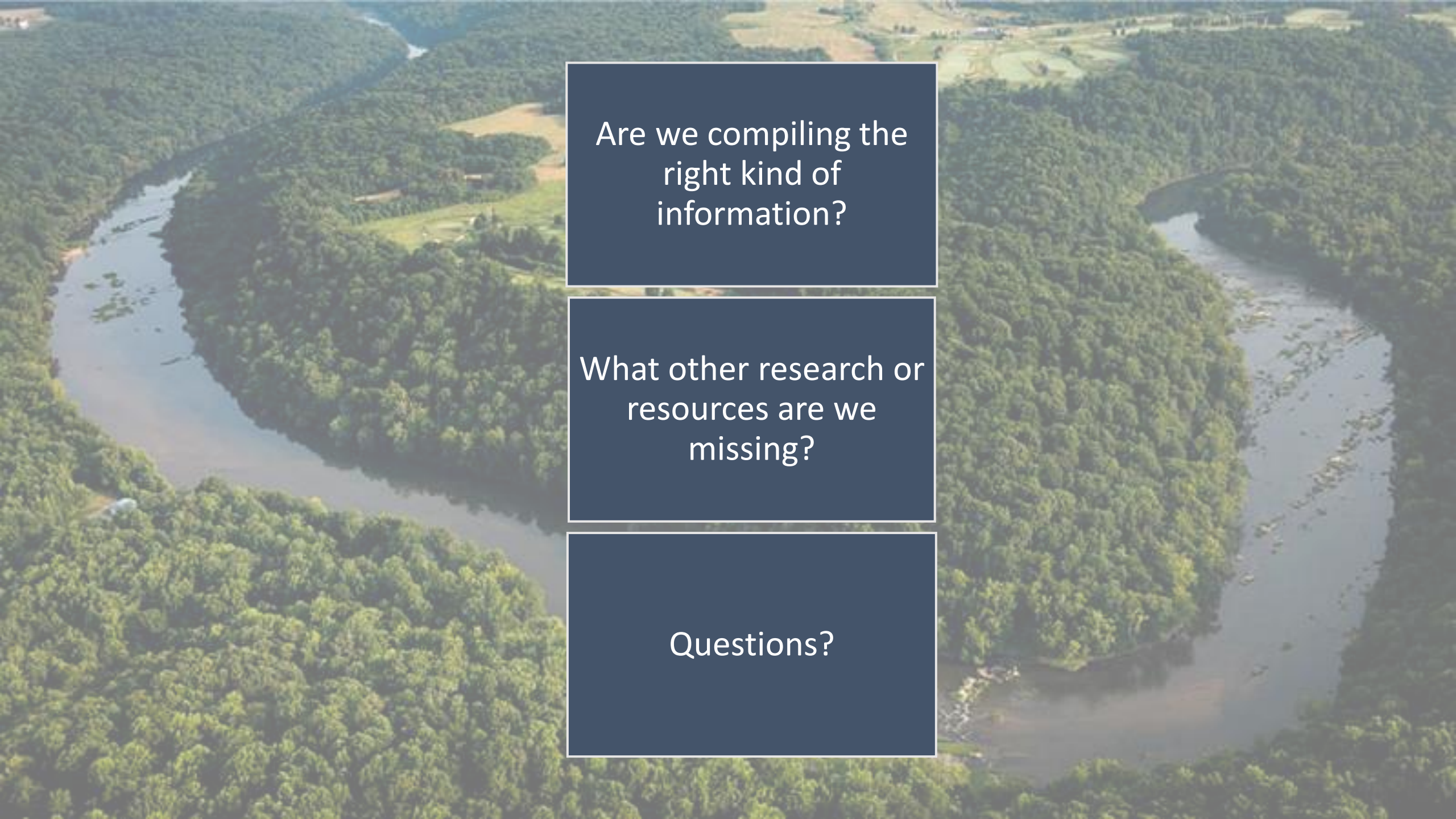
Link to Jamboard in chat



How do we recognize “signals of change” in a watershed?



What is the appropriate management response to those signals of change?


Are we compiling the right kind of information?
What other research or resources are we missing?
Questions?